

Claims

1. A method for transmitting data in a multi-carrier system where data from an individual user is transmitted on multiple subcarriers, the method comprising the
5 steps of:
 - de-multiplexing a data stream to produce a plurality of de-multiplexed data streams;
 - spreading de-multiplexed data streams with a spreading code to produce a plurality of chip streams;
 - 10 time shifting each chip stream by a predetermined amount; and
 - transmitting each time-shifted chip stream on a predetermined subcarrier.
2. The method of claim 1 further comprising the step of code multiplexing a spread pilot with the chip stream.
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3. The method of claim 1 wherein differing spreading codes are used for at least two of the de-multiplexed data streams.
4. The method of claim 1 further comprising the steps of:
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 - spreading a pilot stream to produce a spread pilot stream;
 - time shifting the pilot stream by a predetermined amount; and
 - transmitting the pilot stream on a predetermined subcarrier.
5. The method of claim 1 further comprising the steps of:
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 - spreading a pilot stream to produce a spread pilot stream;
 - combining the pilot stream with a chip stream from the plurality of chip streams; and
 - wherein the step of time shifting each chip stream comprises the step of time shifting the combination of the pilot stream and the chip stream.
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6. A method for transmitting data, the method comprising the steps of:

de-multiplexing a symbol stream to produce a plurality of de-multiplexed symbols;

spreading each symbol with a spreading code to produce a plurality spread symbols, each comprising a predetermined number of chips;

5 for a first transmission interval, mapping a first chip of a spread symbol to a predetermined subcarrier; and

for a second transmission interval, mapping the first chip of a spread symbol to a second subcarrier, wherein the second subcarrier differs from the first subcarrier.

10 7. The method of claim 6 further comprising the steps of:

spreading a pilot stream to produce a spread pilot stream comprising pilot chips; and

15 combining the pilot chips with chips of the spread symbols such that the chips mapped to the subcarriers comprise a combination of spread symbol chips and pilot chips.

8. The method of claim 6 wherein the de-multiplexed symbols comprises a code multiplexed pilot.

20 9. The method of claim 6 further comprising the step of, for the first transmission interval, mapping the spread symbol to subcarriers k to $k+SF-1$, and for the second transmission interval, mapping the spread symbol to m to $m+SF-1$, wherein SF is a spreading factor and k does not equal m .

25 10. A method comprising the steps of:

receiving a multicarrier signal comprising a plurality of subcarriers;

demodulating the multicarrier signal to produce a chip stream;

despreading the chip stream with a pilot code during a first symbol period to produce a first channel estimate for the first symbol period;

30 despreading the chip stream with the pilot code during a second symbol period to produce a second channel estimate for the second symbol period;

generating a third channel estimate only for a portion of the first symbol period based on the first and the second channel estimates; and

generating a fourth channel estimate for a second portion of the first symbol period based on the first and the second channel estimates.

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11. The method of claim 10 wherein the multicarrier signal further comprises a code multiplexed pilot.

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12. The method of claim 10 wherein the step of receiving the multicarrier signal comprises the step of receiving a multicarrier signal having relatively time-shifted chip streams existing on at least two subcarriers.

13. The method of claim 10 wherein the first and the second symbol period occur during a same time period and comprise chips transmitted on differing subcarriers.

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14. The method of claim 10 wherein the first and the second symbol periods are non-overlapping in time.

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15. The method of claim 10 wherein the first and the second symbol periods are non-overlapping in frequency.

16. An apparatus comprising:

a de-multiplexer, de-multiplexing a data stream to produce a plurality of de-multiplexed data streams;

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a spreader spreading the de-multiplexed data streams with a spreading code to produce a plurality of chip streams;

a time shifter, time shifting each chip stream by a predetermined amount; and

a transmitter, transmitting each time-shifted chip stream on a predetermined subcarrier.

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17. An apparatus comprising:

a de-multiplexer, de-multiplexing a symbol stream to produce a plurality of de-multiplexed symbols;

a spreader, spreading each symbol with a spreading code to produce a plurality spread symbols, each comprising a predetermined number of chips; and

- 5 a mapper, for a first transmission interval, mapping a first chip of a spread symbol to a predetermined subcarrier and for a second transmission interval, mapping the first chip of a spread symbol to a second subcarrier, wherein the second subcarrier differs from the first subcarrier.

10 18. An apparatus comprising:

a receiver, receiving a multicarrier signal comprising a plurality of subcarriers and demodulating the multicarrier signal to produce a chip stream;

- a channel estimator, despread the chip stream with a pilot code during a first symbol period to produce a first channel estimate for the first symbol period, and
15 despread the chip stream with the pilot code during a second symbol period to produce a second channel estimate for the second symbol period; and

- an interpolator generating a third channel estimate only for a portion of the first symbol period based on the first and the second channel estimates and generating a fourth channel estimate for a second portion of the first symbol period based on the
20 first and the second channel estimates.